White Paper Report

Report ID: 110128

Application Number: PF-50410-13

Project Director: Jennifer Pye (museum@monheganmuseum.org)

Institution: Monhegan Historical and Cultural Museum Association

Reporting Period: 10/1/2013-2/28/2015

Report Due: 5/31/2015

Date Submitted: 5/10/2015

White Paper

Grant #: PF-50410-13

Planning for a Sustainable Preservation Environment

Project Director: Jennifer Pye

Monhegan Historical and Cultural Museum Association

Submitted May 10, 2015

Final Performance Report

In August 2013, the Monhegan Museum received a Sustaining Cultural Heritage Collections Planning Grant to assemble a group of skilled professionals to work collaboratively to develop a plan that addresses several serious environmental issues that pose a threat to the long-term care and conservation of the Museum's varied and significant collection of artwork, documents, photographs, and artifacts chronicling the unique history and culture of Monhegan Island, Maine. This team's focus was on three distinct areas of remediation. The first being the investigation and small scale implementation of effective non-mechanical climate-control options for the Museum's seasonal display facilities; the second being the pursuit of optimizing the existing climate-control systems in the Museum's off-season storage vaults with an eye towards increased energy-efficiency, and ultimately, reduced energy consumption; the third, to explore sustainable options to improve the collections environment in the non-historic structures.

Background

The Monhegan Museum was formed in 1960 as a committee of Monhegan Associates, Inc., an organization devoted to preserving the wild lands and traditional way of life on Monhegan Island. In 1962 the Monhegan Island Light Station was purchased by the Monhegan Associates for use as a museum. After several years of repairs, renovations, and collecting of historic materials, the museum opened to the public in 1968. By 1983 rapid growth of the museum necessitated the formation of a separate organization dedicated exclusively to the well-being of the museum; this organization, the Monhegan Historical and Cultural Museum Association was incorporated in 1984.

The mission statement adopted by the Association in 1984 is "The Mission of the Monhegan Historical and Cultural Museum Association, Inc. is to preserve and display objects of historical and cultural significance to Monhegan Island, Maine, and in so doing to provide a source of information and fascination about Monhegan Island for the benefit of the residents of the island and all other interested persons. Doing this will involve: 1) collecting and making available to the public works of art by artists who have worked on Monhegan Island, materials related to the island's history and its various settlements, items concerning the domestic life, work and natural history of the island, information and objects related to the ocean, boats and navigational aids near the island, as well as photographs, documents, and printed matter concerning any significant aspects of the island and its inhabitants; and 2) to maintain as authentically as possible the historic Monhegan Light Station to be used as a museum within which to store and display materials related to the Association's mission."

Originally, the Museum was comprised of the Monhegan Island lighthouse and keeper's dwelling, the oil shed, workshop, a garage and a shed. Rapid growth of the Museum's collections, and concern for the preservation and security of the exceptional art collection led to the 1998 reconstruction of the Assistant Keeper's House and construction of the Main Vault. The re-creation of the Assistant Keeper's house, the original having been taken down in 1928 after the Assistant Keeper position was eliminated, returned the Light Station to its early 20th century appearance. In 2004 further expansion of the collection led to the creation of a second vault on the second floor of the garage which houses the Ice Cutting exhibit. Also in 2004, the house and studio designed, built, and used by the artist Rockwell Kent and later owned and used by the artist James Fitzgerald was bequeathed to the Monhegan Museum with a substantial collection of Fitzgerald's paintings, watercolors, and drawings. The Monhegan Island Lighthouse and Quarters and the Rockwell Kent House and Studio are all listed on the National Register of Historic Places.

History of the Project

The Monhegan Museum has taken several steps to identify and address environmental quality issues with the goal of optimizing preservation conditions in its facilities. In 2006 the museum received a Conservation Assessment Program grant. John Leeke, Preservation Consultant conducted a survey of the buildings; and Ronald S. Harvey, Conservator examined the collections. In 2007, Gary E. Albright, Conservator of Photographs and Paper conducted an assessment of the Monhegan Museum's photographic collections. In 2010 Jamie Grey, Energy Auditor conducted a survey of the Museum.

Several of the goals of the previously mentioned Conservation Assessments have been achieved since receiving the reports in 2007. The light tower has undergone a complete restoration which included removing all lead based paint, repointing the stone structure, and refurbishing the leaking lantern. Electrical concerns within the exhibit areas have been addressed and a dory that resides next to the museum has been conserved. Original photographs have been removed from exhibition and replaced with duplicates, and the most important and heavily used parts of the photograph collection continue to be digitized and duplicated to reduce handling of the originals. As recommended in the energy audit, spray foam insulation was installed under the floor of the Main Vault in 2012.

Each of the three individual preservation consultants recommended that the Monhegan Museum purchase and install data loggers and begin monitoring the environment in storage and exhibition spaces. Environmental monitoring is an essential step for the long term preservation of the museum buildings and collections. Based on these recommendations, the Museum successfully applied for a NEH Preservation Assistance Grant awarded in 2011. The Monhegan Museum worked in conjunction with the Image Permanence Institute (IPI) of Rochester, NY to optimally position 10 PEM2 environmental data loggers throughout the Museum's storage and display facilities to record temperature and relative humidity conditions. IPI worked with the Monhegan Museum staff with on-site consultation and training covering environmental monitoring and the development of a long-term preservation strategy. Through this monitoring staff has been able to identify threats resulting from high humidity, temperature fluctuation, and unacceptable light levels.

Project Activities

In late September of 2013 the project team of Jennifer Pye, Ron Harvey, Jeremy Linden, John Leeke, and Victor Lord met on Monhegan. Prior to this meeting all consultants were provided with previous CAP reports and PEM2 data to review. Scott Fitch of ICDS, who designed the existing climate control system for the vaults, was on site to work with the Monhegan Plantation Power District (MPPD) and was able to consult with the project team. Two days were spent reviewing data from eleven PEM2 monitors throughout the Museum, placing ten additional PEM2 loggers, installing electric loggers on both vaults to measure power consumption, reviewing the set points for both vaults, making visual assessments of the collections spaces, and developing a small scale implementation plan to investigate how passive changes within the historic structure could help to improve environmental conditions.

The focus of the primary implementation project was what is referred to as the History Room in the northwest corner of the Keeper's House. Data from prior years showed that the environmental conditions within the building closely mirrored the outside ambient conditions. These conditions include relative humidity measurements that are regularly higher than 70%. Areas of the first floor are prone to mold outbreaks, particularly in the spring time, and there is significant risk of metal corrosion throughout the year. The goal was to mitigate moisture levels without making any major physical changes to the structure, and that repairs should be in keeping with the historic architecture and construction of the building. If the intervention positively affected the room environment, the procedure would be expanded to other rooms in the Keeper's House to mitigate high RH conditions within collection rooms in this building.

An additional implementation project was undertaken in the modern replica of the Assistant Keeper's House (built in 1998).

The work plan devised in September 2013 was:

1. Water flows through the gutters and downspouts and onto the ground on the southern side of the Keeper's House. It then runs then under the building (porch) and into / through the crawl space under the building. Water will be diverted around the building and across the driveway by installing pvc pipes from the downspouts and under the porch, over the drive and open to the hill.
2. There are spaces between the planks of the subfloor. These spaces will be packed with fiber caulking to reduce the flow of moisture into the room above.
3. The windows in the History Room are not tightly fitted, and the storm windows do not open and close easily. Windows will be refurbished with new seals and maintenance will be performed on storm windows.
4. The basement foundation and exterior access have a number of points that show visible daylight, indicating areas where atmospheric moisture can transfer readily from the outdoors to inside. These openings will be sealed to reduce airflow.
5. Closed cell spray foam insulation will be applied beneath the Office/Archives in order to create a vapor barrier beneath the building and to reduce heating costs.

Actual Accomplishments:

1. Below freezing temperatures prevented the underground re-routing the water from the downspouts during the winter of 2013-2014, this task was completed in October 2014.

2. Anticipated spaces in the subfloor were not found. The planks fit together tightly and fiber caulking was not necessary.
3. John Leeke was contracted to perform window maintenance, work was completed October 1, 2013.
4. Fissures in basement foundation were not addressed before September 30, 2014 as the below freezing temperatures during the winter of 2013-2014 did not allow mortar to be applied.
5. In late June of 2014 spray foam insulation was installed beneath the office space.

Monitoring results:

1. During the off-season (December – early June) rigid foam insulation board inserts were installed in the 3 doorways in the History Room so that the environmental changes brought on by the refurbishing of windows, and reducing the draft through the floor could be measured.
2. PEM2 temperature and humidity monitors were placed in the crawl space beneath the room, in the adjacent basement space, and in the History Room to collect data and compare conditions in the History Room with those in the rest of the Keeper's House. The loggers were downloaded during the winter and the consultants reviewed the data.

All consultants involved in the project met to review collected data, the results of the small implementation project, and discuss ideas and strategies to improve collections spaces in October 2014. The results of these discussions, and input from Scott Fitch of ICDS form the basis for the Monhegan Museum's Plan for a Sustainable Preservation Environment (MMPSPE). (APPENDIX A--PLAN)

Accomplishments

The primary goals of this project were to create a plan to:

1. Improve the environmental conditions in the historic display areas of the museum to the greatest degree possible through passive, non-mechanical methods.
2. Optimize the operating parameters of the existing climate control equipment
3. Find effective sustainable solutions to create a better preservation environment in the archives and gallery spaces of the museum.

Realization of goals:

1. A multi stage plan was drafted to help protect collections in the historic buildings by employing window treatments to prevent light damage, re-routing water to control moisture, fashioning chimney vents to improve ventilation, and replacing halogen lights with LEDs.

2. While a plan has been created for evening shut downs and setbacks for the climate control equipment based on monitoring the electric use and conditions in these spaces (APPENDIX B LINDEN), we were not able to employ these strategies as both vaults lack a programmable controller. The MMPSPE includes new controllers to enable increased operator control.
3. The Monhegan Plantation Power District's upcoming migration from diesel generators to micro turbines presents exciting new opportunities for the Monhegan Museum to make use of the waste heat from the electrical generation in order to heat the museum archives, and the two vaults.
4. The Ice House Vault will be expanded to include the first floor of the building to provide more storage for artworks, archives and historic objects. This will entail insulating the entire building and replacing the current climate controls with a system designed to handle the enlarged space.
5. A freezer will be purchased for the storage of color photographs in order to increase longevity.
6. Solar thermal dehumidification will be utilized in the Gallery and Archives space.(APPENDIX C ICDS)
7. Incandescent lighting in the Gallery space will be replaced with energy efficient LED lighting with a CRI (color rendering index) of 95.

Audiences

Information regarding grant activities has been shared with several Maine institutions that are considering similar pursuits. There has also been an ongoing dialogue with MPPD about partnering to reduce energy costs and consumption for both parties. The Community Energy Department at Island Institute in Rockland, Maine has taken an active interest in this project and made several suggestions for sources of funding to move forward with parts of our implementation plan; and have made other coastal and island entities aware of the innovative approaches that are being employed. Jeremy Linden has referenced this project in 7 conferences and workshops across the country over the past 12 months. (APPENDIX D Linden conferences)

Evaluation

Though a formal evaluation was not conducted, the following observations were made throughout the course of the project:

- The members of the NEH staff were extremely helpful in offering advice while the grant application was being prepared. Their suggestion of multiple outside consultants proved invaluable for addressing the various challenges posed by our remote location and unique circumstances.
- Working with consultants who were familiar with the Monhegan Museum, the structures, and the systems in place, allowed the planning team to dive into the project with a relatively small amount of time spent on site reviewing the institution, goals, and history of the project.
- Rich Shea, who had been a part of this project since the placement of the PEM2s in 2011, and was the most knowledgeable staff member regarding the climate control systems left the

museum in August of 2013. Due to the small population of Monhegan, replacing Rich with someone equally familiar with HVAC systems has not been possible at this time. Fortunately, Scott Fitch of ICDS has been spending time on the island to consult with MPPD and was able to communicate directly with Jeremy Linden of IPI about the climate control equipment.

- Also due to the small population of the island, work was not always completed during the anticipated timeline. Because of numerous prior commitments, extreme weather, and calls upon his time, the Museum's caretaker was not able to install the downspouts and piping to lead water away from the buildings until October of 2014. This has resulted in less time to gather data and determine the effectiveness of this strategy.
- In the future, when creating a project plan we will leave a larger time cushion to account for adverse weather and outside obligations of participants.

Continuation of the Project

The Monhegan Museum is committed to achieving the goals set forth in the MMPSPE. To that end an application for a 2015 Sustaining Cultural Heritage Collections Implementation Grant has been submitted and smaller local and regional grants continue to be pursued in order to achieve pieces of the MMPSPE.

PEM2 data is gathered and reviewed on a monthly basis to evaluate the success level of strategies employed to date, and to maintain awareness of risks to collections. Artwork and artifacts continue to be rotated out of display areas to minimize the long term effects of being displayed in adverse environmental conditions.

Communication with MPPD and Scott Fitch regarding the upcoming installation of micro-turbines at the power plant is ongoing, and MPPD provided a Letter of Commitment for the 2015 SCHC grant application. (APPENDIX E MPPD)

Long Term Impact

The end result of this planning activity is an executable plan to effectively mitigate the high moisture conditions in the Museum complex and to increase the operating efficiency of the existing HVAC equipment. Implementation of this plan will allow a greater percentage of the Museum's collection to be on display for a longer period of time, thus increasing public exposure to Monhegan's unique cultural heritage. With improved environmental conditions, other institutions and private individuals will be much more likely to lend relevant works of art for display in the Museum's annual exhibitions, providing a more well-rounded representation of Monhegan's contribution to American art.

Addressing the moisture issue in the Keeper's House will allow the storage of more artifacts in this building. This will free up room in the storage vaults for the acquisition of more Monhegan-related works of art. It will also extend the expected life of the objects and artifacts on display in the Keeper's House during the summer season, thus increasing the likelihood that they will be around for future generations. Implementation of this plan will result in a much longer lifespan for the documents, photographs and artifacts in the Archive/Office of the Assistant Keeper's House, thus ensuring that the Monhegan Museum can remain a resource for future historical, cultural, and artistic research. The improvement of environmental conditions in the Kent/Fitzgerald and Keeper's House portions of the Museum complex will prolong the lifespan of these historically significant buildings and preserve a significant part of the island's cultural heritage.

Current electric rates on Monhegan Island are $.70/kWh. This is 500% higher than the average rate in the State of Maine. Energy savings resulting from this plan will result in significantly lower expenditures for electricity. This will allow the museum to put more of its limited resources toward structural maintenance, curatorial work hours, and programming. By utilizing the waste heat created by MPPD's micro-turbines the museum will assist MPPD in transitioning from 30% efficient diesel generators to an 80% efficient power plant- a benefit for the entire community. This combination of unique strategies to address the various conditions at the Monhegan Museum as well as our partnership with MPPD will serve as an example of creative site specific solutions for other institutions.

Monhegan Museum
Plan for a Sustainable Preservation Environment

February 2015

Beginning with an NEH Preservation Assistance Grant awarded in 2011, the Monhegan Museum has worked in conjunction with the Image Permanence Institute of Rochester, NY to optimally position 10 PEM2 environmental data loggers throughout the Museum's storage and display facilities to record temperature and relative humidity condition. The information provided by these instruments documents periodic, potentially damaging moisture and mold conditions in the Museum's non climate-controlled facilities: the Lighthouse Keeper's House and the Gallery, where artwork and historical artifacts are displayed on a seasonal basis; and the Office, where documents and photographs are archived year-round. While the environmental conditions in the Museum's climate-controlled storage vaults, where preservation protocol dictates all artwork is stored when not on display, is substantially more favorable, the energy consumption of the HVAC systems represents an ever-increasing proportion of the Museum's operating budget. A reduction in these energy costs will provide budgetary room for facilities maintenance and increased curatorial work-hours for the care and preservation of the Museum's collections. The alarming conditions made apparent by environmental monitoring led to the pursuit of an NEH Sustaining Cultural Heritage Collections Planning Grant which was received in 2013. The research conducted and data gathered throughout the planning grant forms the foundation for the Monhegan Museum's Plan for a Sustainable Preservation Environment.

Electricity on Monhegan Island is generated by the Monhegan Plantation Power District (MPPD). At the same time that the Monhegan Museum is exploring sustainable options, MPPD will be replacing their diesel generators with energy efficient micro turbines in an effort to reduce emissions and fuel consumption. The two projects will be mutually beneficial as heat recovery from these turbines will be utilized to reduce the Museum's dependence on electricity and propane to control climate in collections spaces. The close proximity of the Museum to MPPD will allow water heated by the steam created by the turbines to be piped to the museum.

Due to the diverse conditions and construction methods in each structure, each building has been assessed independently and has a unique plan.

The Keeper's House- The flagship of the Monhegan Museum, this historic structure is the largest single item in our collection. The nature of the construction and the visitor experience does not lend itself to mechanical controls. Using the Secretary of the Interior's Standards for the Treatment of Historic Properties, and the advice of Preservation Consultant John Leeke, every effort will be made to improve the climate in this building through non mechanical means including:

1. *Address fissures in the foundation.* There are several small holes and cracks in the foundation through which daylight can be seen. Some of these are where pipes once fed a now obsolete cistern; others are symptoms of age and modifications over the years. All of these fissures will be

filled with mortar appropriate to the structure and in keeping with what is used in close proximity to the gap.

2. *Replace water tank in basement.* Due to the high elevation of the Lighthouse, the municipal gravity feed water system does not always supply sufficient water pressure for the facility. The basement of the Keeper's House holds an open plastic barrel which serves as a water tank for the lighthouse complex to alleviate this issue. This tank will be replaced with a sealed barrel unit to reduce condensation in the basement.
3. *Replace and relocate electric panel*. Though only ten years old, the high humidity levels in the basement have caused significant corrosion on the electric panel in the basement and on the electrical contacts within it. An electrician will be hired to replace this panel and relocate it to the top of the basement stairs where conditions are significantly drier, and the panel is still not accessible to visitors.
4. *Fill holes in flooring.* Before the lighthouse was automated in 1960, families inhabited the dwelling. The furnace and radiators that were used at this time have long since been removed, but holes in the floor leading to the basement show where the radiators once stood. Wooden plugs will be fitted in these holes to reduce moisture infiltration from the basement to the exhibition spaces.
5. *Refurbish windows.* Many of the windows are drafty, or cannot be opened. Work will be undertaken to refurbish the windows with proper seals and to make them easily operational for summertime ventilation.
6. *Storm Windows.* John Leeke will design wooden low-E glass storm windows according to the National Window Preservation Standards. These will be installed on the south and west sides of the building to reduce solar gain in the summer and to diminish UV damage to artifacts.
7. *Window Shades*. Install double roller solar and blackout shades on all windows to reduce light damage and heat gain. The solar shades will improve preservation conditions without blocking the spectacular views of Muscongus Bay that are an integral part of the experience of the Keeper's House, while the blackout shades will be employed when the museum is closed to the public.
8. *Use the existing two chimneys for ventilation.* Install operational vents in the chimneys to allow moist air to flow up and out of the building.

The Assistant Keeper's House

The Assistant Keeper's House is modern construction comprised of two distinct areas which must be addressed separately.

The Gallery- This area is used primarily to house our annual exhibitions showcasing a particular Monhegan artist, period, or movement in Monhegan art. Artwork is displayed in the gallery from approximately June 15th to October 15th annually. The environmental conditions in this space during those summer months pose significant risk to the works on display. With an average RH of 76% and temperature of 68 degrees, active mold growth has been observed on the backing of artworks displayed in this area. These conditions accelerate mechanical damage, and natural aging. This large open space with cathedral ceilings and no insulation or vapor barrier beneath the floor poses unique challenges. A mixture of solar thermal dehumidification and heat recovery technology will be used to mitigate moisture and improve preservation conditions. Solar thermal collectors will be placed on the large south-facing roof of the office and will be used to power a hot-water fired desiccant dehumidifier.

1. *Moisture barrier*. A layer of 6 mil plastic will be laid over the exposed earth beneath the gallery to prevent condensation from the soil from transmitting to the underside of the gallery floor.
2. *Spray Foam Insulation*. A 1 inch layer of closed cell spray foam insulation will be applied to the underside of the floor and coated with an ignition barrier for additional fire protection. This will provide a supplementary moisture barrier as well as help to control fluctuations in temperature.
3. *Mechanical Dehumidification*: While it is not practical to attempt to achieve vault-like conditions in the gallery space, improvements in the collections environment can be achieved through mechanical dehumidification to lower the RH of the space. The large south facing roof of the office portion of the Assistant Keeper's House is ideally situated to power a solar thermal desiccant dehumidifier.
4. *Lighting*: Currently the light in the Gallery space is provided by four 300 watt incandescent light bulbs that are suspended from the ceiling approximately 20 feet in the air. This situation is not ideal for several reasons. These include: the cost to power these high wattage lights is prohibitive; and to replace a bulb in one of these lamps requires a crew of three people with an extension ladder at a cost of over $100 per light bulb change. Replacing the bulbs with CFLs is not an option due to the deleterious effects of florescent light on artwork and artifacts. Using input from the nearby Farnsworth Art Museum about their experience with implementing LED lighting, (http://www.ledtronics.com/Media/ProductsInTheNews.aspx?newsID=1025) an LED lighting system With a CRI (color rendering index) of 95 has been designed and will be installed in the gallery to conserve energy and reduce maintenance costs related to bulb replacement.

The Office/Archives- The solar thermal dehumidification system for the gallery will be shared with the office/archives to further protect the delicate archives and photographs that are stored in this space. Heat recovery from the Monhegan Plantation Power District's micro turbine generators will replace the current propane heaters to provide a comfortable climate throughout the year. As recommended by Gary Albright, photograph conservator in 2007, Color slides and photographs will be placed in vapor proof packaging, removed from the office and placed in freezer storage in the enlarged Ice House Vault (see below).

The Main Vault

The aging mechanical systems in the Main Vault will be replaced with more efficient modern equipment that will take advantage of heat recovery from MPPD rather than relying solely on electric heat, and will allow museum staff to adjust temperature and humidity set points remotely. This enhanced operator control will allow staff to program night time shut downs, and modify set points seasonally to allow colder temperatures in winter months. Based upon experimentation, this is a promising strategy to improve preservation conditions and conserve electricity, but it cannot be achieved with current equipment. An energy logger will be placed to monitor the efficacy of the adjustments.

The Ice House Vault

In order to conscientiously house the growing collections of the Museum it will be necessary to convert the downstairs of the Ice House to a vault and create a space closer to the rest of the Museum's displays to house the ice cutting exhibit. To repurpose this 14.5 x 20.5 foot structure and create an energy efficient space without altering its external appearance, the cedar shakes on the exterior will need to be removed, a vapor barrier and a thin layer of reflective foam insulation installed, and cedar shakes reapplied. Fiberglass insulation will be laid in the stud wells and covered with fire-rated drywall. Museum shelving for artifacts and mobile wire screens will be installed to allow for archival storage and an energy efficient, frost-free, upright freezer selected according to the guidelines in NPS Conserve O'Gram 14/10 and 14/11 will be used to house color photographic slides and prints. The current mechanical system which controls the environmental conditions for the second floor of the vault will be undersized for this expanded collections space. A more modern system will be employed with the ability to use heat recovered from MPPD; and remote access to enable shut downs and set point adjustment without accessing the mechanics. As with the main vault, an energy logger will be installed to allow the monitoring of electric use, and the operating parameters that have been determined to be the most favorable in the Main Vault will be employed as a strategy for optimizing storage conditions in the Ice House Vault.

The Kent/Fitzgerald Legacy

Of critical concern in these two structures are the environmental conditions within the Kent/Fitzgerald Studio. This building stands much as James Fitzgerald left it when he departed for a painting trip to Ireland in 1971, where he passed away. Over 350 artworks, frames, canvases, and materials that Fitzgerald used to make his own paints are housed in the studio.

1. *Climate controlled space*. As the conditions do not appear to be having a negative effect on the building itself, and the alterations necessary to apply a mechanical system in this space would require the sacrifice of the historic integrity of this building, a new climate controlled vault will be constructed nearby. This will eliminate the need to transport the works across the island, and provide storage for the entire collection rather than just the small portion that has been moved in the past. As the size of the Fitzgerald collection of art and artifacts is stable with few items added or removed over time, a 16 by 16 foot structure is anticipated to be sufficient for storage needs. This will be a concrete block structure, emulating the construction of the Main Vault at the lighthouse, with insulation and sheathing on the outside of the block, museum storage systems on the inside and a climate control system operating on the same parameters as the Main Vault. *Moving moisture away from the building*. In order to further lower the RH within the Studio, vegetation will be cut back farther from the building, and ground leaders will be added to the downspouts from the rain gutters on the upslope side of the house. These will carry the water under the building and pour it out on the down slope.
2. *Install a moisture barrier beneath the building*. Debris will be cleared from beneath the building with sections of all materials that were once part of the building saved and accessioned into the collection, (e.g. original or early corrugated downspouts). The ground beneath the building will be graded to create a smooth slope that will readily drain to the down slope side of the building.
   A 6 mil fiber reinforced layer of plastic will be laid on the ground and covered with a layer of large flat paving stones. The plastic will prevent moisture from rising from the soil, and the paving stones will encourage water to flow from beneath the building to the down slope. Additionally the weight of the large paving stones will prevent them from washing away in heavy rains, and they will secure the plastic barrier.

Final Report
February 13, 2015

Monhegan Museum
1 Lighthouse Hill, Monhegan, Maine

Mechanical System Optimization and Environmental Data Analysis
October 2013 – January 2015

Jeremy Linden, Senior Preservation Environment Specialist
Image Permanence Institute

Image Permanence Institute ▪ Rochester Institute of Technology ▪ 70 Lomb Memorial Drive Rochester, New York 14623 ▪ Phone (585) 475-5199 ▪ www.imagepermanenceinstitute.org

A. Project Overview/Introduction

The Monhegan Museum contracted with the Image Permanence institute to help complete their 2013-2015 NEH Sustaining Cultural Heritage Collections Planning Grant. IPI consultant Jeremy Linden, Senior Preservation Environment Specialist, worked with Jenn Pye, Curator of Collections, a team of Monhegan Museum staff, and fellow consultants Ronald Harvey and John Leeke to review and analyze mechanical system operation with a focus on sustainable operation, energy reduction, and improvement and maintenance of preservation quality in collection storage areas. The project looked at five Museum buildings on Monhegan Island – the Main Vault, the Ice House, the Keeper's Cottage, the Office/Gallery, and the Rockwell Kent/James Fitzgerald Studio.

Two onsite visits were conducted, the first in October 2013, and the second in October 2014. The first visit included meetings with the project team, discussion of goals for the project, and documentation of the buildings and the applicable mechanical systems. Dataloggers were installed in the mechanical systems that served the Main Vault and the Ice House Vault. Museum staff pulled data throughout 2013 and 2014. The second visit consisted of in-depth data analysis, review of testing conducted in the History Room of the Keeper's Cottage, and discussion of potential testing and strategies for preservation and energy savings moving forward. In addition, the team participated in extensive planning discussions for strategic development of sustainable collections storage on the island.

B. Contract Objectives

The project had three basic objectives:

- Documentation and analysis of current building and mechanical system operation.
    - IPI was responsible for the primary documentation of the mechanized spaces of the Museum, and worked closely with the consulting team to document environmental conditions and behavior in the un-mechanized buildings.
- Experimentation with mechanical and passive strategies to reduce energy usage in mechanized buildings and mitigate moisture issues in Museum buildings.
    - The ability to experiment with mechanical strategies was limited by the available controls technology, however the data gathered during the project identified several strategies that could be applied with controls modifications.
    - Passive experimentation was conducted in the Keeper's Cottage and identified several means of moisture mitigation that can be applied throughout the Museum buildings.
- Strategize for future collections storage and preservation environments to hold expanding Museum collections, with a focus on passive, low-energy solutions, potentially using renewable energy sources.
    - These efforts concentrated on solutions for the Rockwell Kent/James Fitzgerald Studio and the Ice House.

This report serves as the final deliverable on the contract, and covers the findings of the data analysis and experimentation with environmental management strategies, identification of future energy saving and preservation improvement strategies, and recommendations for each of the structures studied.

C. Findings and Recommendations

Main Vault

The Main Vault is served by a small AHU with a DX (direct expansion) air conditioner, separate electric dehumidifier, and electric heat/reheat that is housed on an attached shed at the back of the building. Conditioned air is supplied from two floor registers in the center aisle, while the return air is pulled back from floor registers on the outer sides of the room, three registers to a side. (See *Appendices 1 and 2* for Main Vault diagrams.) Dataloggers were installed in the following locations:

- Supply Air

- Return Air
- Dehumidified Air
- Cooled Air
- Main Vault Amperage (taken from the main power supply box to the building)

Findings

Analysis of nearly four years of environmental data collected from the Main Vault shows that the building is very capable of holding a reasonable preservation environment. Summer temperatures are largely held successfully at 72°F, with relative humidity (RH) levels consistently between 45-65% RH depending on outdoor dew point temperatures. Shoulder seasons, particularly the month of May (before cooling and dehumidifying start in earnest), show a trend of high RHs due to continuing low space temperatures and increasing dew points. Winter temperatures are allowed to drop to 49-50°F, with regular occasions of warmer conditions due to warm days and radiant energy. Even with no humidification, RHs rarely drop below 30% and typically run closer to 40%.

One goal for the project was to determine what operational adjustments to the mechanical operation of the AHU that serves the Main Vault could be tested. Based on the amperage data taken from the main power supply to the building, there appear to be four basic components associated with energy consumption:

- Normal air handler fan operation
- Cooling operation
- Dehumidifier operation
- Lighting operation.

What is significant about the building operation (based on energy usage) is that, while the summer space temperature is held within a 3°F band (roughly 69-72°F), the cooling coil/dehumidifier cycle only about six times per day to maintain this band. There is typically about a three-hour gap between cycles, and longer gaps during night hours are not uncommon. This pattern of operation indicates that the building is relatively well insulated, and able to coast for long periods of time even with full exposure to solar heat load. Based on this, one appropriate test would be a complete system shutdown during nighttime hours, stopping any current nighttime fan operation. Due to the control design on the system, this test can currently only be conducted manually, which is not practical given the pattern of occupation of the Museum. An upgrade to the control system, which would allow for remote access control of system operation, would enable this testing potential. It is likely that system shutdowns could also be applied in the winter months as well.

Recommendations

Generally, conditions in the Main Vault should be as cool as the system can maintain while staying within a band of 30 to 55% RH. Due to the practice of holding low temperatures in the Vault during the winter months, low RHs have not typically been a concern to date. The shoulder seasons show times where, to keep RHs below 55%, the Museum may want to consider adding some heat to reduce the RH, a practice commonly known as conservation heating.

Winter set points, from a collection care perspective, could be allowed to drop even lower than the current 49-50°F. Using a space temperature set point of 45°F or even 40°F would further improve the seasonal preservation condition while also reducing the energy spent on heating.

Overall, the seasonal environmental goals for the Main Vault, based on observed system performance and capability, should be roughly 70°F/53% RH (based on a 52°F dew point) in summer, and, if possible, 40°F and no lower than 30% RH in winter (10°F dew point). In the shoulder seasons the key is make sure that the dew point temperature doesn't rise too high while the temperature remains low, as has happened in the month of May in the past. The Museum may want to work toward using conservation heating (humidistatic control) during these periods. Capital upgrades to consider include an upgrade to of the system controls to allow for adjusted operation schedules, and potentially a change out of the dehumidifier to achieve a lower dew point condition (and thus lower temperatures and RHs in summer).

Ice House Vault

The current Ice House Vault is served by a system similar to that installed in the Main Vault. The Ice House Vault is served by a small AHU with a DX (direct expansion) air conditioner, separate electric dehumidifier, and electric heat/reheat that is housed in an attached shed at the back of the building. Conditioned air is supplied from three overhead diffusers on the east wall, while the return air is pulled back from a lower register near the entry door. (See *Appendix 3* for Ice House Vault diagram.) Dataloggers were installed in the following locations:

- Supply Air
- Return Air
- Dehumidified Air
- Cooled Air
- Ice House Vault Amperage (taken from the main power supply box to the building).

Findings
As with the Main Vault, the Ice House AHU has proven capable of holding steady environmental conditions, but at higher dew point conditions, resulting in lower quality preservation conditions overall and a particular risk to the works on paper stored in the Vault area.

Summer conditions are the primary concern. Space data from 2014 indicates that the best typical dew point achieved is 55°F, with the dew point condition jumping above 60°F during the month of August. As a result, space temperatures had to remain high (typically >74°F) in order to keep RH conditions at a moderate 50 to 65%. Overall, the space is at risk for increased rates of chemical decay. The best case Preservation Index[1] (PI) numbers are around 29 in the summer, indicating an accelerated rate of chemical decay during that period. Space data also indicates a risk of metal corrosion based on long periods of RH above 55%. (See Appendix 4 for an explanation of IPI's Preservation Metrics.)

The Ice House Vault currently has the same control limitations as the Main Vault regarding the opportunity to test energy-savings operation. Data available from the mechanical system dataloggers indicate that the dehumidifier at the Ice House runs far more often than the unit on the Main Vault. While a shutdown for the current space is worth testing, the second floor location and more regular system operation may indicate less "coasting" ability for the space.

Winter space temperatures are held at 50°F, with occasional spikes due to outside weather conditions. Interior RH conditions vary, largely based on outdoor dew points, and do drop below 30% for periods of days up to a week. As with the Main Vault, the opportunity exists to move to a 40°F winter temperature set point in order to decrease energy costs and improve preservation quality. In both cases, if this set point were tested, staff should watch for periods of high outdoor dew points that may cause indoor RH to spike – the cooler space temperatures would intensify the high RH.

Recommendations
The most pressing question for the Ice House is the plan to repurpose the entire building to serve as storage space. As a non-historical structure, the primary concern is to maintain an external appearance that fits in with the rest of the Museum complex. Ideally, the goal should be to mimic the construction of the Main Vault – install a vapor barrier and thermal insulation (if possible) in the walls, consider a solution to mitigate moisture coming up through the floor, and work to completely renovate the inside of the building. As part of this, the current mechanical system (which only serves the upstairs Vault) should be replaced and sized to control the entire building.

The Keeper's Cottage
The Keeper's Cottage, which serves as the primary display area for the Museum's historic collection, is a two-story, un-mechanized structure on the northwest section of the Museum complex. The Cottage is connected by an enclosed catwalk to the historic lighthouse, which is operated and maintained by the U.S. Coast Guard. Dataloggers were initially installed as part of the Museum's 2011 Preservation Assistance Grant. IPI deployed one additional logger in the History Room as part of this Planning Grant.

---

[1] The PI metric represents the rate of chemical decay, based on T and RH data at a single moment in time. A PI of 75 or more indicates a slow rate of chemical decay in organic materials, 45 to 75 indicates an acceptable rate of chemical decay for most materials, and 45 or lower indicates an accelerated rate of chemical decay in organic materials, especially vulnerable materials.

Historically, portions of the Keeper's Cottage has suffered from mold outbreaks in the spring of the year, primarily in the Fishing Room. This necessitates annual cleaning of the walls and ceiling when the Museum is opened in late May/early June. The data shows that indoor conditions mirror outdoor environmental conditions very closely, with slight lags in dew point. The goal for this project was to see whether indoor moisture levels could be mitigated through passive strategies that do not compromise the historic integrity of the structure, which is listed on the National Register of Historic Places.

Findings

Overall high moisture levels in the outdoor and indoor environments pose a challenge to preservation in the Keeper's Cottage. While the Cottage's role in the Museum is significant, a disconnect remains between preserving the structure of the building and preserving the collections contained within. What is best for the building, both in terms of historic integrity and energy consumption, is a passive solution that will allow the building to function as it was originally intended—as a breathing structure that buffers the inside from outdoor extremes. While the hope is that passive, structural strategies may be able to slow moisture equilibration through the structure and reduce the overall moisture content, it is unlikely that these strategies will be able to fully mitigate preservation risks to the collection materials in the building. As such, the Museum should consider the impact of the interior preservation environment on the collection (seasonally cold and warm with high RHs year round, creating risk for chemical, biological, and mechanical decay) and consider the possibility of moving additional pieces of the collection out of the building during the winter months.

Recommendations

The consulting team settled on a combination of traditional repairs, guided by John Leeke, and temporary barriers to try to control moisture flow through the History Room as a pilot project. Noted structural issues that could contribute to moisture movement through the space include historic windows and associated trim in need of repair, gapped floorboards in various parts of the building, and problems with runoff and groundwater in the basement below the space. Recommendations include:

- Repair of windows in the History Room (completed by John Leeke)
- Construction and installation of temporary insulated doors for winter use in the entrances to the room (completed by Museum Staff)
- Filling of air gaps in the building foundation
- Re-direction of runoff water around the building, rather than allowing it to drain under the structure

The completion of the window repairs and the insulated doors during the winter of 2013/2014 resulted in a smoothing of the RH patterns in the space. RH levels were not brought consistently below the 70% RH limit, but fluctuations in dew point temperatures were reduced, indicating a slowed response to outdoor moisture contents. Further work, including re-routing of the runoff and filling the air gaps, will hopefully reduce the overall moisture content of the environment by reducing moisture entry into the structure, resulting in a lowering of the overall RH.

Office/Gallery

The Office/Gallery space is situated on the south side of the Museum complex. The Gallery is an un-mechanized seasonal space, used for exhibits during the summer season and closed during the winter months, with all artwork either moved to the Main Vault or returned to lending institutions.

Findings

Concerns regarding active mold growth and environmental requirements from lending institutions have led the Museum to considering installing mechanical controls in an unfinished crawlspace area underneath the structure. The datalogger in the space indicates high year-round RH levels (with RH almost constantly above 70% during the summer season) similar to those experienced in the Keeper's Cottage.

Recommendations

The goal for the Gallery area is to mitigate high RH concerns for the portion of the year that artwork is present in the space. The space can remain uncontrolled for the remainder of the year. Design goals/parameters should be to try to achieve 70°F and 50 to 55% RH from June to October. One consideration, given the height of the space, is that there is no need to try to condition the entirety of the room—controlling a vertical band that encompasses the normal hanging height of the artwork would be sufficient.

Kent/Fitzgerald Studio

The Rockwell Kent/James Fitzgerald Studio is managed by the Fitzgerald Legacy (an arm of the Monhegan Museum) and is located on Horns Hill on the island. The building, which consists of one main room, two smaller storage areas—one currently holds Fitzgerald's works, the other his material and supplies—and a bathroom, is un-mechanized, and listed on the National Register of Historic Places. Currently, a large portion of the Legacy's holdings of Fitzgerald's artwork is housed in one of the smaller storage rooms. One goal of this project was to determine what options might exist to improve long-term preservation of the Fitzgerald Legacy (building and collections).

Findings

The artwork in the studio consists primarily of various media on paper, and some on canvas, both of which are susceptible to chemical and mechanical degradation over time. The Legacy first installed a datalogger in the building in October 2009. Since then, the data shows yearly environmental conditions that mimic outdoor patterns. Summer temperatures trend hotter than outdoors, with daily highs between 70 and 80°F. Indoor and outdoor dew points are similar, resulting in indoor RH levels that, while not as high as the outdoor RH, are still consistently above 65%.

These conditions indicate both the porous nature of the building envelope as well as the increased decay risk to the artwork housed there. Data indicates an accelerated rate of chemical and mechanical decay, and a yearly risk of mold outbreaks in late summer. Winter conditions are somewhat more favorable to the collection, with the unheated building regularly dropping to >40°F and a slower rate of chemical decay. However, RH levels remain high throughout the winter, consistently above 60% and regularly rising to 70 to 80%, placing the collection at risk for damage due to mechanical expansion of the media.

Recommendations

As with the Keeper's House, the best solution is to approach the preservation of the structure and the preservation of the collection separately. Ideally the structural preservation should be approached with historically appropriate passive strategies to buffer the building from outdoor conditions, similar to the work proposed for the Keeper's Cottage.

The collection is better suited to separate storage outside of the historic structure. Because of space limitations and historic integrity in the studio, the possibility of creating appropriate storage inside the building would be difficult to achieve. A better option is to explore onsite external storage modeled after the Main Vault. A well-insulated structure (for thermal and vapor) with an appropriate mechanical system could create acceptable preservation conditions during the summer months at minimal energy cost, while still taking advantage of naturally cooler temperatures during the winter. One set of design options would be to design the system to maintain 70°F/50% RH in the summer, and 40°F at no lower than 30% RH in the winter.

D. Summary of Recommendations for Both Operational Changes and Capital Improvements

The work of the consulting team resulted in key recommendations for each of the five buildings considered in the project, as well as a few general recommendations.

Main Vault

- Test reducing the winter temperature set point to 40-45°F. It is very important during the test period to watch whether the RH rises beyond 55%.
- Explore mechanical system control upgrades that would make it possible to test shutdowns, particularly during the summer months.
- For capital improvement, consider a system upgrade to allow for better dew point control and better preservation conditions during the summer months.

Ice House Vault

- Test reducing the winter temperature set point to 40-45°F. It is very important during the test period to watch whether the RH rises beyond 55%.
- Test night-time manual system shutdowns during the summer months to determine their viability for use as energy savings measures for the Vault. If the resulting fluctuation in the space is acceptable, explore control system upgrades to allow this system to be controlled remotely.
- For long-term storage solutions, consider outfitting the lower level of the Ice House for environmentally-controlled storage. Appropriate vapor barrier and thermal insulation will need to be installed for the walls and floor. The goal is to maximize interior storage potential without altering the exterior appearance.
- The renovated Ice House will need one mechanical system to serve the entire building. Recommended design set points are 70°F/50% RH for summer and 40°F/30% RH (minimum) for winter.
- Any renovated storage design plan should be appropriate for housing both artwork and artifacts.

Keeper's Cottage

- Continue insulating doors for winter environment isolation.
- Continue moisture abatement work, including rerouting of drainage and sealing of the basement.
- Review which artifacts currently housed in the Cottage during the winter are most susceptible to mold, corrosion, and mechanical damage brought on by high winter and spring RH levels, and discuss options for appropriately controlled winter housing for these items (the new Ice House Vault may be one option).

Office/Gallery

- Explore mechanical system design and installation for summer dehumidification.
- Potential design set points could be 70°F/50% RH for the vertical band where the artwork is displayed, with no purposeful condition of the high ceiling areas.
- Explore the potential for a photo-voltaic array on the south-facing roof of the Office building.

Kent/Fitzgerald Studio

- Explore the potential for a stand-alone storage facility on the Kent/Fitzgerald property, to be modeled after the Main Vault. The building should be sized to accommodate the current Fitzgerald collection with room for estimated growth.
- Potential design set points would be 70°F/50% RH in summer, and 40°F/30% RH (minimum) for winter.
- Investigate necessary structural repairs for the long-term preservation of the Studio building.

General

- Move forward with alternative-energy solutions (photo-voltaic or micro-turbine heat recovery from the Island power system) and discuss how they apply to proposed changes to the Museum facilities.
- Use the data and recommendations from the NEH Planning Grant to pursue an NEH Sustaining Cultural Heritage Collections Implementation grant or an IMLS Museums for America grant.

G. Conclusion

Currently the greatest challenge to creating excellent year-round preservation environments on the island are energy costs. Rather than aiming for unsustainable mechanical operation to create low-moisture, low-temperature environments for collections storage, the more sustainable approach is to find a reasonable balance between an acceptable summer time preservation environment and one that takes advantage of seasonal conditions during the winter. There are two basic considerations to this approach:

- Working to passively reduce loads is a better solution than reliance on mechanical solutions.
- Preservation of historic structures and historic collections is rarely best achieved simultaneously.

As such, the recommendations and findings outlined in this report seek to use sound construction, with excellent thermal and vapor barriers, to reduce the amount of influence the outdoor summer environment has on interior storage conditions, allowing for adequate summer storage conditions (roughly 70°F and 50% RH) at lower energy costs. These same envelope qualities can mute some fluctuation due to outdoor variability during the winter months when storage temperatures can be allowed to drop as low as 40-45°F as long as the RH does not regularly creep above 55%.

The current energy generation on the island creates a prohibitive environment for using mechanical intervention as a means to environmental control, even in the buildings that are appropriately mechanized. As changes are made to energy generation on the island, the goal should be to consider how the Museum might partner to use any waste/recovery energy. In addition, the Museum is currently taking the right path by exploring renewable energy resources (primarily photo-voltaic) that may be appropriate solutions on the island. If the energy cost or availability changes in the future, it does not necessarily negate the general sustainability strategies (passive control and reduction of load), but may allow for better preservation conditions to be considered, designed or maintained during the challenging summer season. One important discussion to have might be whether it would be desirable to achieve better preservation conditions (60°F/50% RH) in the primary collections storage structures if the energy generation and cost for the Museum were somehow significantly reduced.

The Monhegan Museum is at a unique place in the current professional field as a small institution with a very significant collection that is working carefully and diligently to find sustainable solutions to its preservation challenges. In many ways the Museum's approach and effort can serve as a model to other small-to-medium sized institutions, and we would like to encourage you to share your experience and findings with the rest of the field. We have enjoyed the opportunity to work with your organization.

H. Appendices

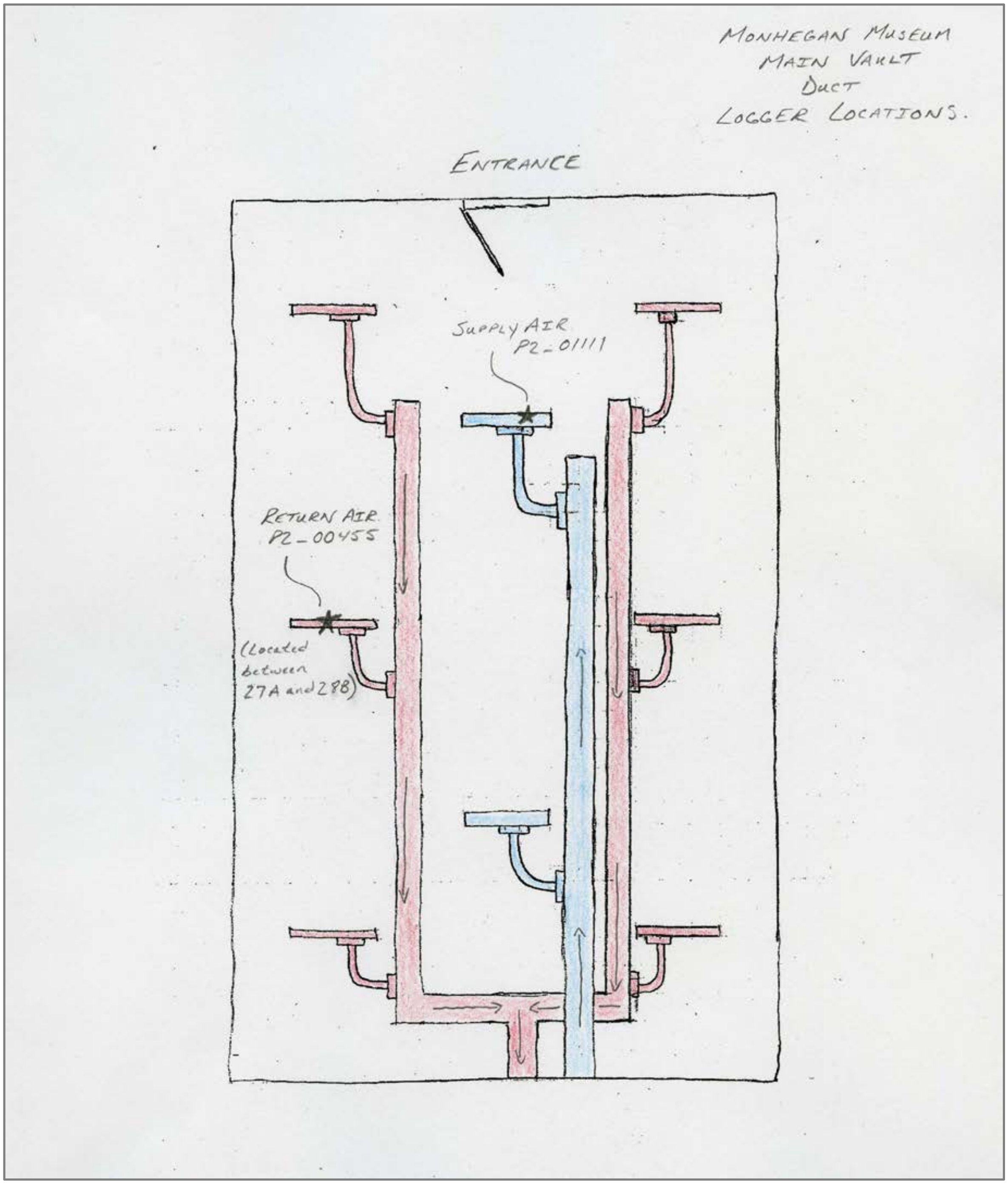
1. Main Vault Duct – Logger Locations

2. Main Vault AHU – Logger Placement / Flow Diagram

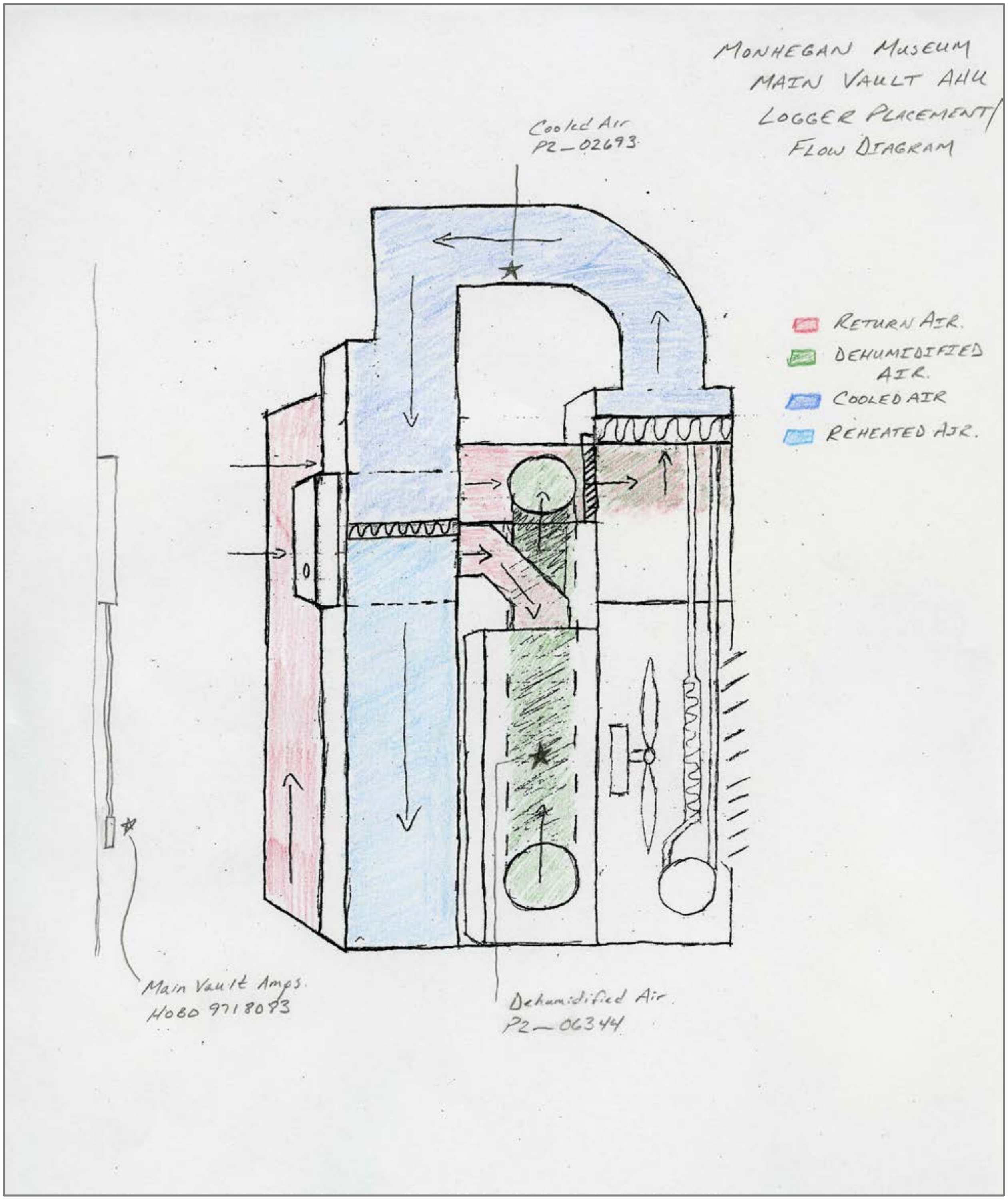
3. Ice House Vault – Air Flow/Logger Placement

4. IPI Preservation Metrics

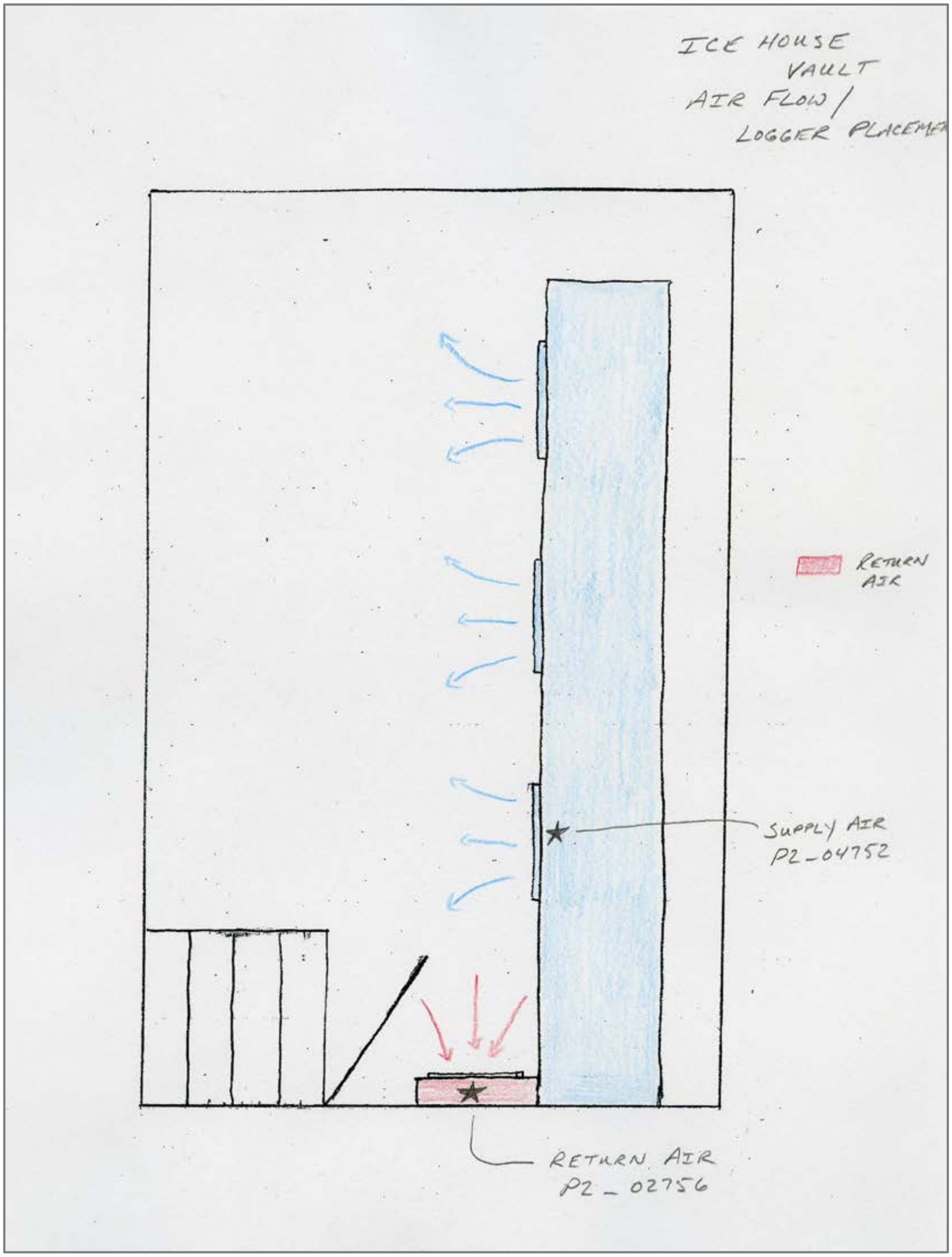
Appendix 1: Main Vault Duct - Logger Locations



Appendix 2: Main Vault AHU – Logger Placement / Flow Diagram



Appendix 3: Ice House Vault – Air Flow/Logger Placement



Natural Aging

Measures:
The rate of "natural aging" as determined by the rate of spontaneous chemical change in organic materials.

- TWPI integrates the T and RH values as they change over time into a single estimate of the cumulative effects of the envrionment on the rate of chemical decay.
- TWPI is helpful as a quantitative comparison of the preservation quality of different storage locations or environments.

Applies to:
All Organic Materials (paper, textiles, plastics, dyes, leather, fur, etc).

TWPI Metric	Interpretation
TWPI > 75	GOOD
45 < TWPI ≤ 75	OK
TWPI ≤ 45	RISK

Metal Corrosion

Measures:
The effect of the environment on metal corrosion. The % EMC max represents the maximum amount of moisture that was present in hygroscopic collection materials. Because metallic corrosion is dependent on available moisture, the % EMC gives us an idea whether or not metallic objects (mainly ferrous metals) would corrode in such an environment.

Applies to:
All organic materials (paper, textiles, plastics, dyes, leather, fur) or inorganic materials with organic films.

Corrosion Metric	Interpretation
Max EMC ≤ 7.0	GOOD
7.1 ≤ Max EMC ≤ 10.5	OK
Max EMC > 10.5	RISK

Mold Risk

Measures:
The risk for growth of the xerophilic mold species on collection objects or in collection areas.

Applies to:
All organic materials (paper, textiles, plastics, dyes, leather, fur) or inorganic materials with organic films.

Mold Risk Metric	Interpretation
MRF ≤ 0.5	GOOD
MRF > 0.5	RISK

Note: There is no "OK" rating for mold risk. At a MRF of 0.5, conditions are appropriate for germination of spores. By alerting RISK of mold growth at germination, the user is aware of the potential of mold growth before any visible or vegetative mold will appear. This allows for time to react and prevent formation of vegetative mold.

Mechanical Damage

Measures:
Three aspects of moisture content that promote mechanical or physical damage:

1. Max % EMC: Is it too damp? Will paper curl? Will emulsions soften? Will wood warp?
2. Min % EMC: Is it too dry? Will paper become brittle? Will emulsions crack?
3. % DC: How great are the fluctuations between the most damp and the most dry? Has expansion and contraction - from absorption/de-sorption of water - put physical stress on the collection materials?

Applies to:
Metals or materials with metal components

Mechanical Damage Metrics	Interpretation
Min EMC ≥ 5% AND Max EMC ≤ 12.5% AND %DC ≤ 0.5%	GOOD
Min EMC ≥ 5% AND Max EMC ≤ 12.5% AND 0.5% < %DC ≤ 1.5%	OK
Min EMC < 5% OR Max EMC > 12.5% OR %DC > 1.5%	RISK

Innovative Construction & Design Solutions, LLC
419A Whitfield Street
Guilford, CT 06437
Phone: (203) 453-8596
Fax: (203) 453-7012

Prepared by: Scott D. Fitch, P.E.
Date: November 26, 2014

This narrative has been prepared to describe the new and or upgraded HVAC systems intended for the environmentally controlled exhibit and storage structures at the Monhegan Museum.

DESIGN CRITERIA

When determining environmental requirements for a collections exhibit and/or storage facility, there are some subtle difference between environmental design criteria and limits for preservation. Typically the design criteria are more conservative allowing for factor of safety when trying to stay within those limits. Based on discussion between the Preservation Consultant, Jeremy Linden, Curator of the Monhegan Museum, Jenn Pye, and the Environmental Control Consultant, Scott Fitch, environmental design criteria for the various climate controlled spaces/structures were developed and are proposed in the table below:

	Winter Temp / RH	Summer Temp / RH	Daily Fluctuation
Main Vault	40 °F / 30 %	70 °F / 50 %	± 5 % RH
Ice House	40 °F / 30 %	70 °F / 50 %	± 5 % RH
Gallery	N.R.	N.R. / 50 %	± 5 % RH
Office	68 °F / 30 %	N.R. / 50 %	± 5 % RH
Fitzgerald Vault	40 °F / 30 %	70 °F / 50 %	± 5 % RH

ENVIRONMENTAL CONTROL SYSTEM DESIGN

Based on the above criteria, each system will be designed and constructed as necessary to maintain the specified environments.

Main Vault

The Main Vault which has been very stable has aging HVAC equipment (almost 17 years old) and outdated controls. The existing components will be replaced in kind, but upgraded as necessary to meet the environmental criteria in the summer. The equipment will include an air handler for air distribution, split system air conditioner for cooling, a high efficiency dehumidifier for dehumidification, an electric heater for humidistatic heating (a.k.a. passive humidification) and minimum temperature control, and high efficiency particulate filters. Also, some of the ductwork and insulation will be upgraded to improve the system efficiency and fit of the components. The most significant upgrade will be the control system which will include a programmable controller with a graphic user interface that will include trending, alarms (local and offsite via email/txt/etc.), as well as remote monitoring/access.

Ice House

The Ice House storage, which will be expanded, will be completely replaced with a system capable of handling the larger space design (whole building versus just the attic). The HVAC equipment will include an air handler for air distribution, split system air conditioner for cooling, a high efficiency dehumidifier for dehumidification, an electric heater for humidistatic heating (a.k.a. passive humidification) and minimum temperature control, and high efficiency particulate filters. Also the existing digital controls which are almost 11 years old with be replaced with a new programmable controller with a graphic user interface that will include trending, alarms (local and offsite via email/txt/etc.), as well as remote monitoring/access.

Gallery

The Gallery which currently has no environmental control systems will be upgraded to include dehumidification. Since this facility is seasonal, relative humidity control is required only in the summer. The system will include a new air handler for air distribution, a high efficiency dehumidifier for dehumidification when temperature permits, a duct heater (electric or hot water) for humidistatic heating (a.k.a. for passive dehumidification in this case) when temperatures get too low for effective dehumidifier operation (< 65 deg F), and high efficiency particulate filters. Also controls will be required which will include a new programmable controller with a graphic user interface that will include trending, alarms (local and offsite via email/txt/etc.), as well as remote monitoring/access.

Office

The Office, which is currently only heated via propane wall heaters, will be upgraded to include controllable heating, humidification and dehumidification. In the winter, this is an occupied work space requiring temperatures meeting minimum comfort levels for an office environment. As such, the higher temperatures will require the addition of moisture to meet the criteria above. In the summer, dehumidification will provide high relative humidity control. The system will include a new air handler for air distribution, a high efficiency dehumidifier for dehumidification, a duct heater (electric or hot water) for heating, and high efficiency particulate filters. Since this structure is connected to the Gallery, the controls will be shared with the gallery for cost effectiveness.

Fitzgerald Vault

This is a new structure to be climate controlled much like the Main Vault. The HVAC equipment will include an air handler for air distribution, split system air conditioner for cooling, a high efficiency dehumidifier for dehumidification, an electric heater for humidistatic heating (a.k.a. passive humidification) and minimum temperature control, and high efficiency particulate filters. Controls will include a new programmable controller with a graphic user interface that will include trending, alarms (local and offsite via email/txt/etc.), as well as remote monitoring/access.

SUSTAINABLE SYSTEMS

Much like indoor environmental design preserves collections; sustainable design preserves our natural resources and quality of the external environment. With indoor climate control, it is very difficult to achieve the desired results entirely through passive means (versus mechanical), so sustainable systems can help offset the carbon and cost footprint of mechanical systems. This project is looking to utilize two sustainability options for reduction of the museum's energy use as well as to support improved efficiency of the island electric power system.

Monhegan Plantation Power District (MPPD)

Currently the stand-alone power plant for Monhegan Island is being replaced with a combined heat and power plant (CHP) in 2015. This plant will include new sustainable micro-turbine generators with integral heat recovery packages. The plan is to utilize some of the waste heat from the operating micro-turbines to heat the museum due to its proximity to the plant. In this case it is anticipated that there will be additional cost involved to deliver hot water (or glycol) to the museum including hot water piping, pumps, controls, trenching, etc. The utilization of waste heat will result in increase power plan cycle efficiency up to about 80% as compared to approximately 30% delivered by conventional reciprocating engine diesel generators. This is an alternate to all of the "electric" heaters described in the building above (excluding the Fitzgerald Vault which is not near the plant). In addition, a high efficiency (95+%) propane condensing hot water boiler would be provided as a back-up and/or in the event the power plant may not be able support the full heating demands of the museum (e.g. lowest winter electric demand periods).

Solar Thermal System

Heating and dehumidification processes require a significant amount of thermal energy and because there is a restricted amount of solar PV that can be added to the stand alone power grid, solar thermal energy is a logical choice to supplement the CHP thermal energy for the heating and reheat processes. This will require solar thermal collectors, a storage tank (or tanks) to store the energy, and controls. Based on the south facing roof of the Office, there is approximately 200 sq feet of usable gross are for collectors. Based on a preliminary solar energy run for 200 sq ft of collector, the total thermal energy generated is equal to approximately 26 100-lb bottles of propane or 400 gallons of home heating oil. Since this will be part of the Office/Gallery, the controls will be shared with the gallery controls for cost effectiveness.

Jeremy Linden has spoken about the Monhegan Project at:

1. 30 May 2014 – American Institute for Conservation of Historic and Artistic Works Annual Conference, talk entitled "Creating Sustainable Preservation Environments: Funding, Process, and Practice." San Francisco, CA

2. 11 August 2014 – Society of American Archivists Annual Conference, discussed as part of a workshop entitled "Managing Storage Environments for Sustainable Preservation." Washington, DC

3. 29-30 September 2014 - "Sustainable Preservation Practices for Managing Storage Environments," Boston, MA. NEH-funded workshop produced by IPI, Monhegan used as a case-study.

4. 28-29 October 2014 - "Sustainable Preservation Practices for Managing Storage Environments," New York, NY. NEH-funded workshop produced by IPI, Monhegan used as a case-study.

5. 4-5 November 2014 - "Sustainable Preservation Practices for Managing Storage Environments," Berkeley, CA. NEH-funded workshop produced by IPI, Monhegan used as a case-study.

The Monhegan project will also be used as a case study in these upcoming workshops:

6. 9-10 December 2014 - "Sustainable Preservation Practices for Managing Storage Environments," Washington, DC. NEH-funded workshop produced by IPI, Monhegan used as a case-study.

7. 13-14 January 2015 - "Sustainable Preservation Practices for Managing Storage Environments," Fort Worth, TX. NEH-funded workshop produced by IPI, Monhegan used as a case-study.

Monhegan Plantation Power District
P.O. Box 127, Monhegan, Maine 04852

November 30, 2014

Nadina Gardner, Director
Sustaining Cultural Heritage Collections
Division of Preservation and Access
National Endowment for the Humanities
400 Seventh Street, SW
Washington, DC 20506

Dear Dr. Gardner,

I write to express the Monhegan Plantation Power District's (MPPD) commitment to working with the Monhegan Museum to utilize heat recovery from our upcoming micro-turbine generators to provide heat for the Museum's collections storage spaces.

MPPD has long aimed to make renewable power generation in a remote island setting sustainable, both in terms of cost and environmental impact. This goal is evident in our choice of efficient micro-turbine generators to replace our aging diesel generators. By partnering with the Monhegan Museum we will increase the efficiency of our operation by utilizing the heat created by power generation; and we will be supporting an important cultural institution.

Sincerely,

Willard Boynton

Willard Boynton, Trustee
Monhegan Plantation Power District